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TO THE TAXONOMIC POSITION OF *LECITHOCERA LURIDELLA* CHRISTOPH AND *CARCINA* HÜBNER IN THE SYSTEM OF OECOPHOROID MOTHS (LEPIDOPTERA: OECOPHORIDAE *SENSU LATO*)

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Summary. The taxonomic position of the *Lecithocera luridella* Christoph, 1882 and rank of the group *Carcina* Hübner, [1825] are established on the base of the integrative approach, combining comparative morphological and molecular phylogenetic methods. The belonging of the *L. luridella* to the genus *Carcina* is established on the base of similarity in the male genitalia with the type species of the genus, *Pyralis quercana* Fabricius, 1775. On the base of analysis of sequenced fragments mtCOI and nuclear 28SD1 were estimated genetic divergence of group *Carcina* from other oecophoroid taxa. It is revealed that parameters of genetic distances between nucleotide sequences in representatives of oecophoroid family-group taxa are low, but comparable. Since group *Carcina* equal-deviated from other oecophoroid taxa of family rank it is proposed to consider this group in the status of separate family. The problem with homonymy of family-group name Carcinidae should be solved by referring to the International Commission on Zoological Nomenclature.

Key words: oecophoroid moths, *Carcina luridella*, *Carcina*, integrative taxonomy, taxonomic position, taxonomic rank.

М. Г. Пономаренко, П. Н. Черникова. К вопросу таксономического положения *Lecithocera luridella* Christoph и *Carcina* Hübner в системе ширококрылых молей (Lepidoptera: Oecophoridae *sensu lato*) // Дальневосточный энтомолог. 2018. N 366. С. 1-18.

Резюме. Таксономическое положение *Lecithocera luridella* Christoph, 1882 и ранг группы *Carcina* Hübner, [1825] установлены на основе интегративного подхода, включающего сравнительно-морфологический и молекулярно-филогенетический методы. Принадлежность *L. luridella* к роду *Carcina* установлена на основе сходства исследуемого вида с типовым видом рода, *Pyralis quercana* Fabricius, 1775, в строении гениталий самцов. На основе анализа секвенированных фрагментов mtCOI и ядерного 28SD1 была оценена генетическая дивергенция группы *Carcina* от других экофороидных таксонов. Выявлено, что показатели генетической дистанции между нуклеотидными последовательностями у представителей экофороидных таксонов группы семейства низкие по сравнению с таковыми в других надсемействах микрочешуекрылых, но сопоставимые. На основе равного уклонения *Carcina* от других экофороидных семейств предложено рассматривать эту группу в ранге самостоятельного семейства. Проблему с омонимией названия группы семейства Carcinidae следует решить обращением в Международную Комиссию по Зоологической номенклатуре.

INTRODUCTION

Gelechioid complex includes a number of taxa, the position of which in the system of the order Lepidoptera is debatable in spite of the attempts to solve the problem by modern methods. That is evident from the 3 papers devoted to the system of Gelechioidea which were published during the last 7 years. All of them based on results of extensive analyses of morphological and molecular data and offer significant changes in the system of Gelechioid complex with the reconsidering of taxa ranks and composition of some families (Kaila *et al*., 2011; Heikkilä *et al*., 2013; Sohn *et al*., 2015 online/2016). One of the problematic groups, position of which has been changed most frequently in recent years, is a small genus *Carcina* Hübner, [1825]. Establishing of relationships of the latter is very actual because, until recently, the genus *Carcina* regarded as one of the possible taxonomic position for *Lecithocera luridella* Christoph, 1882, which is the one of the points of present study.

The main goal of present work is establishing of the relationships of *L. luridella* and specifying of the status the group *Carcina*. The integrative approach, combining the morphological and molecular methods, was applied for solving of these taxonomic tasks. Generic association of *L. luridella* was performed by comparative-morphological analysis of the male genitalia of this species and type species of the genus *Carcina*, *Pyralis quercana* Fabricius, 1775. The taxonomic rank of the group *Carcina* was established based on wide molecular-phylogenetic analysis of oecophoroid moths.

MATERIAL AND METHODS

Species sampled. The material on *luridella* and other oecophoroid moths was collected by first author in the southern Primorskii krai (PK, Russia). Insects were attracted on the light, specimens for molecular research were preserved in 96% ethanol and other specimens were processed as dry collection for morphological study.

Species, sampled for molecular study, locality of their collecting and number of voucher are in the Table 1. Studied dry specimens are listed in the item Material examined in the text. Species, for which the nucleotide sequences of mtCOI fragments were taken from GenBank (NCBI), are listed in Table 2.

In total, 64 specimens belonging to 52 species from 15 families of Microlepidoptera were involved in present study. In the Tables, the taxa are given in order mainly according to Catalogue of Lepidoptera of Russia (Sinev, 2008) taking into account changes within oecophoroid moths accepted by Lvovsky (2016).

Table 1. List of Microlepidoptera species sampled for molecular study

Name of species	**Locality**	**Voucher Nos.**
Carcina luridella (Christoph, 1882)	PK, Chuguevskii distr., "Zov Tigra" Nat. Park, Pobedinskaya polyana, 7-11.06.2013	V-254
Ypsolophidae		
Ypsolopha yasudai Moriuti, 1964	PK, Vladivostok, 5 km SEE Okeanskaya st., Bogataya Griva ridge, 15.07.2016	V-345
Ethmiidae		
Ethmia septempunctata (Christoph, 1882)	PK, Khasanskii distr., 14 km SW Slavyanka, Ryazanovka, 12-22.08.2010	V–126
Depressariidae		
Luquetia lobella ([Denis & Schiffermüller], 1775)	PK, Chuguevskii distr., "Zov Tigra" Nat. Park, Milogradovka riv., 22-26.06.2015	V–289
Agonopterix costaemaculella (Christoph, 1882)	PK, Chuguevskii distr., "Zov Tigra" Nat. Park, Milogradovka riv., 22-26.06.2015	V–280
Agonopterix japonica Saito, 1980	PK, Chuguevskii distr., "Zov Tigra" Nat. Park, Milogradovka riv., 22-26.06.2015	V–286
Agonopterix propinquella (Treitschke, 1835)	PK,Vladivostok, Sputnik, 1-3.05.2015	V–275
Peleopodidae		
Agnoea kurentzovi (Lvovsky, 2001)	PK, Chuguevskii distr., Zov Tigra Nat. Park, Milogradovka riv., 22-26.06.2015	V–288
Lypusidae		
Letogenes festalis Meyrick, 1930	PK, Khankaiskii distr., 2 km NE Dvoryanka vil., 8-11.07.2015	V–290

Table 1. Continue

Name of species	Locality	Voucher Nos.
Chimabachidae		
Dasystoma salicella (Hübner, 1796)	PK, Oktyabrskii distr., 48 km NW Ussurijsk, 17 km W Pokrovka, 12-14.04.2009	V–91
Cryptolechiidae		
Eutorna leonidi Lvovsky, 1979	PK, Shkotovskii distr., Anisimovka vil., 10.08.2016	V–335
Oecophoridae		
Deuterogonia pudorina (Wocke, 1857)	PK, Khasanskii distr., 27 km SW Slavyanka, Srednyaya Bay, 9-16.08.2009	V–95
Promalactis parki Lvovsky, 1986	PK, Khasanskii distr., 14 km SW Slavyanka, Ryazanovka, 12-22.08.2010	V–256
Martyringa ussuriella Lvovsly, 1979	PK, Khankaiskii distr., 2 km NE Dvoryanka vil., 8-11.07.2015	V–294
Periacma sp.	PK, Khasanskii distr., 27 km SW Slavyanka, Srednyaya Bay, 9-16.08.2009	V–97
Lecithoceridae		
Odites ussuriella (Caradja, 1920)	PK, Khankaiskii distr., 2 km NE Dvoryanka vil., 08-11.07.2015	V–295
Scythropiodes malivora (Meyrick, 1930)	PK, Vladivostok, 5 km SEE Okeanskaya st., Bogataya Griva ridge, 05.08.2016	V–330
Scythropiodes ussuriella Lvovsky, 1996	PK, Vladivostok, 5 km SEE Okeanskaya st., Bogataya Griva ridge, 02.08.2016	V–316
Rhizosthenes falciformis Meyrick, 1935	PK, Shkotovskii distr., 6 km SW Anisimovka vil., 11.08.2016	V–337
Blastobasidae		
Neoblastobasis biceratala (Park, 1984)	PK, Khasanskii distr., 27 km SW Slavyanka, Srednyaya Bay, 9-16.08.2009	V–96
Autostichidae		
Autosticha modicella (Christoph, 1882)	PK, Vladivostok, 5 km SEE Okeanskaya st., Bogataya Griva ridge, 15.07.2016	V-312
Gelechiidae		
Psoricoptera arenicolor Omelko, 1999	PK, Vladivostok, 5 km SEE Okeanskaya st., Bogataya Griva ridge, 27.08.2016	V-347
Psoricoptera gibbosella (Zeller, 1839)	PK, Khankaiskii distr., 2 km NE Dvoryanka vil., 8-11.07.2015	V-352
Hypatima venefica Ponomarenko, 1991	PK, Khasanskii distr., 14 km SW Slavyanka, Ryazanovka, 12-22.08.2010	V-71
Faristenia ussuriella Ponomarenko, 1991	PK, Khasanskii distr., 14 km SW Slavyanka, Ryazanovka, 12-22.08.2010	V-72
Anarsia bimaculata Ponomarenko, 1989	PK, Khasanskii distr., 14 km SW Slavyanka, Ryazanovka, 12-22.08.2010	V-75

Table 2. List of Microlepidoptera species for which the nucleotide sequences of mtCOI are taken from GenBank

Name of species	Voucher	GenBank Accession Nos.
Carcina quercana (Fabricius, 1775)	UKLB39G05	KX043593.1
Tineidae		
Tinea columbariella Wocke, 1877	10ANIC-05087	HQ948716.1
Tineola bisselliella Hummel, 1823	FFOH00122_0101	KU494269.1
Trichophaga tapetzella (Linnaeus, 1758)	MM20697	KX049539.1
Ethmiidae		
Ethmia pusiella (Linnaeus, 1758)	TLMF Lep 08402	KM572295
Depressariidae		
Semioscopis strigulana ([Denis et Schiffermüller], 1775)	TLMF Lep 04799	KX042739.1
Semioscopis steinkellneriana ([Denis et Schiffermüller], 1775)	TLMF Lep 04797	KX042129
Levipalpus hepatariella (Lienig & Zeller, 1846)	MM21082	KT782381.1
Exaeretia ciniflonella (Lienig et Zeller, 1846)	BIOUG16742-E01	KR940502.1
Agonopterix ocellana (Fabricius, 1775)	TLMF Lep 04798	KX042760.1
Depressaria leucocephala Snellen, 1884	TLMF Lep 02724	JF860247.1
Depressaria radiella (Goeze, 1783)	TLMF Lep 04948	KX042381.1
Psorosticha zizyphi (Stainton, 1859)	10ANIC-04066	HQ923097.1
Peleopodidae		
Acria ceramitis Meyrick, 1908	AYK-04-5621	GU828542.1
Elachistidae		
Elachista bifasciella Treitschke, 1833	TLMF Lep 02355	JF859911.1
Chimabachidae		
Diurnea fagella ([Denis et Schiffermüller], 1775)	MM05960	GU828735.1
Cryptolechiidae		
Acryptolechia malacobyrsa (Meyrick, 1921)	KTP-06-0115	KF523762.1
Oecophoridae		
Oecophora bractella (Linnaeus, 1758)	UKLB39G01	KX044171
Promalactis suzukiella (Matsumura, 1931)	-	KM875542

Table 2. Continue

Name of species	Voucher	GenBank Accession Nos.
Lecithoceridae		
Scythropiodes issikii (Takahashi, 1930)	-	KP174664.1
Blastobasidae		
Neoblastobasis perisella Adamski, 2010	USNM:ENT:00196946	GQ330285.1
Lateantenna spiniharpella Kuznetzov et Sinev, 1985	JCS-06-0129	KF523811.1
Autostichidae		
Autosticha pachysticta (Meyrick, 1936)	JCS-06-0168	KF523751.1
Autosticha modicella (Christoph, 1882)	JCS-06-0175	KF523749.1
Lypusidae		
Agnoea josephinae (Toll, 1956)	TLMF Lep 04109	JN307369.1
Carposinidae		
Carposina sasakii Matsumura, 1900	BIOUG01486-E01	KT134033.1

Morphological study. The male and female genitalia were prepared by traditional lepidopterological techniques (Falkovich & Stekolnikov, 1978). The genitalia were studied using a stereomicroscope Nikon SMZ-10. Photos of the male genitalia of *Carcina quercana* (Fabricius, 1775) from the sites Lepiforum, Fauna Europaea, Svenska fjärilar / Fjärilar Lepidoptera and Moth Dissection UK (Wheeler, 2018) were used for morphological comparison.

Molecular study. **Target fragments**. The two target fragments, mtCOI (658 bp) and nuclear 28SD1 (340 bp), were selected for estimation of genetic distances within oecophoroid moths. The phylogenetic analysis with reconstruction of the tree was made on the base of mtCOI only. It was explored in previous study, that pairwise distances (0.00–0.004–0.008) between nucleotide sequences of 28SD1 within oecophoroid moths are low (Trofimova & Ponomarenko, 2015), and processed tree based on them is not informative, consisting of the numerous unresolved branches.

DNA extraction, polymerase chain reaction (PCR) and sequencing. Total genomic DNA from thoracic and abdominal muscle was extracted following the protocol Purification of Genomic DNA from insects appended to Qiagen DNeasy Blood & Tissue Kit (Qiagen GmbH, Hilden, Germany). For each sample of genomic DNA was used one individual of every species. Polymerase chain reaction (PCR) was used to amplify the target fragment of the COI gene using the primer combinations COIF-ALT: ACA AAT CAY AAR GAY ATY GG' and COIR-ALT: TTC AGG RTG NCC RAA RAA YCA, after Mikkelsen et al. (2006). For amplification of the fragment 28SD1 of nuclear ribosomal gene the primer combinations, forward GGG GAG GAA AAG AAA CTA AC and reverse CAA CTT TCC CTT ACG GTA CT are used after Larsen (1992).

Each PCR amplification was performed in a total volume of 10 µl of PCR mixture consisting of 1 µl 10X Taq buffer, 0.25 µl 10 mM dNTP mixture, 0.1 U of DreamTaq DNA polymerase, 0.375 µl 2.5 mM/µl of each forward and reverse primer, 0.5 µl of DNA from each sample and 7,4 µl deionized water. For optimization of PCR 1µl 25 mM $MgCl_2$ was added to PCR mixture. PCR was started from denaturation at 95°C for 2 min 30 s. Thermal cycling conditions (on a ProFlex 3×32-Well PCR System Applied Biosystems-4484073) were 35 x [95°C for 30 s, 50°C for 30 s, 72°C for 1 min 10 s, 72°C for 10 min] and cooling to 10°C for 5 min.

PCR products were cleaned by using a Thermo Scientific FastAP Thermosensitive Alkaline Phosphatase (Thermo Fisher Scientific, USA) and then amplified for sequencing using the protocol of BigDye Terminator v.3.1 Cycle Sequencing Kit. PCR fragments were sequenced in Genetic Analyser 3130xl, (Applied Biosystems, USA). The amplified sequences of mtCOI (644-658 bp in length) and 28SD1 (244-340 bp in length) were aligned and analyzed with the software packages SequenceScanner v 1.0 and MEGA-7 (Kumar *et al*., 2016).

Phylogenetic analysis. The divergence (evolutionary distance) between nucleotide sequences of the mtCOI and 28SD1 fragments was estimated in 36 and 26 species, respectively, of oecophoroid moths and other families of Microlepidoptera. It was done by the Pairwise Distance method, using Kimura 2-parameter model (Kimura, 1980). The phylogenetic tree with inferred relationships between oecophoroid groups was constructed on the base of mtCOI fragment by Neighbor-Joining statistical method, Kimura 2-parameter model with using software packages MEGA-7. To make the results more reasonable, the data from the GenBank on the nucleotide sequences of the target fragment mtCOI in 22 species of oecophoroid groups and 4 species from Tineidae and Carposinidae, as outgroups, were included into analysis.

TAXONOMIC HISTORY OF *LECITHOCERA LURIDELLA* CHRISTOPH, 1882

The species *Lecithocera luridella* Christoph, 1882 was described in a nominative genus of the family Lecithoceridae on the base of a type series including specimens collected at Radde village (Jewish Autonomous Region) and at Vladivostok, Russian Far East. The species has been forgotten about 75 years from last mention in the catalog of Gelechiadae [sic!] (Meyrick, 1925). It is noteworthy that this species is absent in the Key to the insects of Russian Far East, part 2 (Lvovsky, 1999). However, the mentioned issue of the book includes the species *Carcina homomorpha* (Meyrick, 1931). It should be noted that the last species, described from Hokkaido, is a type of monotypic genus *Heterodmeta* Meyrick, 1931, which was treated as the junior synonym of *Carcina* Hübner, [1825] by Moriuti (1982). After a long period of oblivion, the syntypes of the *L. luridella* was studied and designation of the lectotype was made. As result, it was established that *luridella* is conspecific with *homomorpha* and the latter specific name was proposed to consider as junior synonym of the previous one (Lvovsky, 2001).

In the Check-list of broad-winged moths and in the Catalogue of Lepidoptera of Russia the specific name *luridella* was given as senior synonym of *homomorpha* in combination with the genus *Carcina* within the family Oecophoridae (Lvovsky, 2003, 2008). Both the proposed synonymy and the taxonomic position of the species *luridella* were not unanimously accepted by colleagues and adopted in taxonomic sites on Lepidoptera.

Proposed synonymy was reflected on the site "Lepidoptera and some other life forms" (Savela, 2001), but genus *Carcina* is considered there in the subfamily Peleopodinae within the family Depressariidae. The species *homomorpha* and *luridella* are listed in the status of independent taxa in the database of the Museum of Natural History in London, both valid names are given in original combination with generic names: *homomorpha* – with the genus *Heterodmeta* in the family Oecophoridae, and *luridella* with the genus *Lecithocera* adequately in the Lecithoceridae (Beccaloni *et al*., 2003). In the book "The Standard of Moths in Japan", the *homomorpha* is listed as a valid species name in the genus *Carcina* in the family Oecophoridae (Ueda, 2013).

In the recently published Annotated catalogue of the insects of Russian Far East, Vol. 2, *luridella* is given in combination with the generic name *Heterodmeta* Meyrick, 1931, without restoring of this generic name from synonymy, also without indications on establishing of a new combination and transferring of the species into the family Oecophoridae (Lvovsky, 2016). As to the genus *Carcina*, it was excluded from the fauna of the Russian Far East without comments.

As to taxonomic position and status of the genus *Carcina*, it was originally included into the family Oecophoridae *sensu lato*. Meyrick, describing the Australian fauna, proposed Carcinides, as name for group of genera close to genus *Carcina* (Meyrick, 1906). This group was placed there in Depressarianae [sic!] within family Oecophoridae. Later the genus was included into Depressariades group in the same family (Meyrick, 1922). At the end of last century the name *Carcinides* was changed on Carcinini by Nye and Fletcher (1991). Soon Leraut (1992) proposed to consider this group as separate family Carcinidae. Often the genus *Carcina* was not included in any oecophoroid family-group taxa and in the systems resulting from the phylogenetic analyses of superfamily Gelechioidea was given in generic rank along with the family-group taxa (Minet, 1990; Fetz, 1994).

At the beginning of current century the status of separate family Carcinidae in oecophoroid lineage was supported by Kaila (2004). But soon the status of this group was re-considered and it was included into family Peleopodidae (Kaila *et al*., 2011) or family Depressariidae (Heikkilä *et al*., 2013). In lastest phylogenetic analysis this taxon was not included and its position and status were not discussed (Sohn *et al*., 2015/2016). Shortly before cited paper it was established that family name Carcinidae Meyrick, 1906, based on *Carcina* Hübner, [1825], invalid being a junior homonym of Carcinidae MacLeay, 1838 based on *Carcinus* Leach, 1814, in Malacostraca (van Nieukerken *et al*., 2011).

It should be noted that authors traditionally placed this genus into family Oecophoridae (Lvovsky, 1981, 1999, 2003; Hodges, 1983; Ueda, 2013).

Considered taxonomic changes in the position of the species *luridella*, transferring not only between two genera but two families, and genus *Carcina*, which status

had been changed from generic one within Oecophoridae and Depressariidae to separate family, make these taxa "problematic" with uncertain taxonomic position.

RESULTS

Comparative morphological analysis

***Carcina luridella* (Christoph, 1882), comb. ressur.**
Figs 1, 2

MATERIAL EXAMINED. Russia: Vladivostok, Sad-gorod, 12.VI 1994, 3 ♂ (Ponomarenko); Ussurijskii distr., 20 km SE Ussurijsk, Gornotaezhnoe, 11, 12, 14, 16.VI 1995, 5 ♂, 1 ♀ (Ponomarenko); Khasanskii distr., Kedrovaya pad' reserve, 6, 11, 15.VI 1974, 3 ♂ (Ermolaev).

REMARKS. The male genitalia of *luridella* (Figs. 1, 2) are very similar structurally with the genitalia of *C. quercana*, the type species of the genus *Carcina* (Figs. 3–5). The similar characters are as following: the uncus hook-like, narrowed towards the apex; base of the gnathos with two unique long sclerites presumably functioning as apodemes for intersegmental muscles m_1; juxta bearing long processes, pointed to the apex; valva deeply divided into cucullus (dorsal lobe) and sacculus (ventral lobe); cucullus more or less wide and setaceous; sacculus possesses a dense brush of short strong bristles apically, its distal part can be curved inwardly or be unbended (Fig. 5); arcuate aedeagus with sclerotized ventral side.

In addition to genital morphology, there is a similarity in forewing shape with convex costal margin of the forewings and in rest pose of both compared species, characterized by flatly folded wings on the back and extended forward forelegs.

Differences between both species are in the shape of some genital structures and do not concern the general plan of the genital morphology. Thus, the *luridella* is differing by triangular gnathos, more extended distally cucullus with relatively wider distal part, juxta with processes gradually tapered towards apex, whereas the related species, *quercana*, with longitudinally elongated gnathos, juxta with processes widened at the middle. Also differences are in the shape of the forewing apex, which is more rounded in *luridella* and is slightly sharpened in *quercana*.

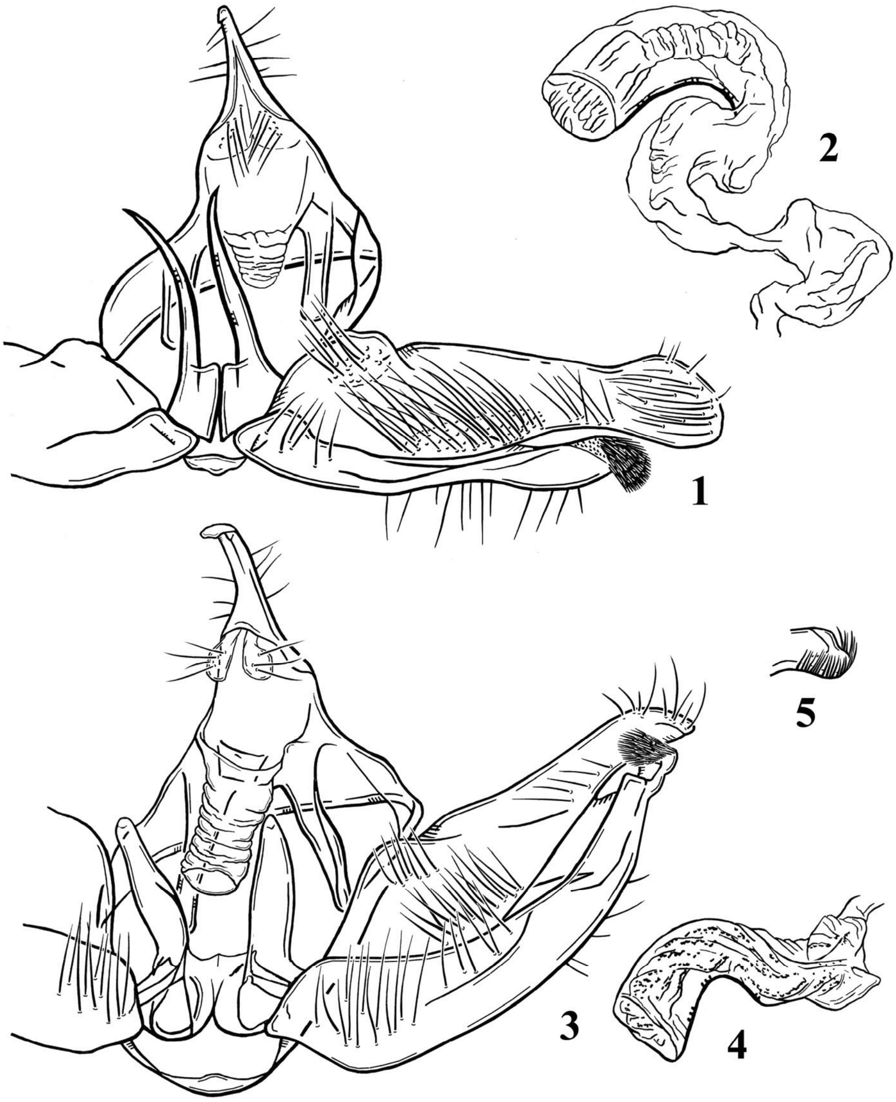
Based on the habitual similarity and close male genitalia of the *luridella* and *quercana*, the first species should be considered within genus *Carcina*: *Carcina luridella* (Christoph, 1882), **comb. ressur.**

DISTRIBUTION. Known distribution to the species is limited to Russian Far East (Jewish Autonomous Region, south of Khabarovskii krai, Sakhalin, Kunashir and Primorskii krai) and Japan (Hokkaido, Honshu, Shikoku).

Phylogenetic analysis based on the mtCOI and nuclear 28SD1 fragments

The estimates of evolutionary divergence between nucleotide sequences of mtCOI fragment in representatives of oecophorid complex (or oecophorid lineage after Kaila, 2004) show that the genus *Carcina* has almost equal genetic distances with species from Depressariidae (0.142–0.163) and Oecophoridae (0.147–0.153)

(Table 3). Both families were considered as most appropriate for taxonomic position of the genus *Carcina*. The intervals of genetic distance overlapping with previous ones are detected between *Carcina* and the species from Ethmiidae (0.145), Lypusidae (0.145–0.175), Cryptolechiidae (0.147), Peleopodidae (0.148–0.175) and Chimabachidae



Figs. 1–5. *Carcina* spp., male genitalia. 1–2 – *C. luridella*, 3–5 – *C. quercana*: 1, 3 – ventral view; 2, 4 – aedeagus, lateral view; 5 – unbended apical part of sacculus. Figures 3–5 are redrawing from photos on the sites Svenska fjärilar and Moth Dissection UK (Wheeler, 2018).

Table 3. Estimates of evolutionary divergence between sequences of mtCOI fragment in representatives of oecophoroid moths and other groups of Microlepidoptera

No	Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	***Carcina quercana***															
2	*Agonopterix ocellana*	0.149														
3	*Agonopterix japonica*	0.153	0.043													
4	*A. propinquella*	0.147	0.06	0.06												
5	*Levipalpus hepatariella*	0.163	0.075	0.089	0.089											
6	*Psorosticha zizyphi*	0.148	0.072	0.079	0.091	0.094										
7	*Exaeretia ciniflonella*	0.157	0.101	0.108	0.093	0.107	0.114									
8	*Depressaria radiella*	0.144	0.094	0.091	0.087	0.117	0.103	0.105								
9	*Depressaria leucocephala*	0.144	0.075	0.084	0.089	0.112	0.101	0.108	0.084							
10	*A. costaemaculella*	0.147	0.089	0.093	0.101	0.118	0.114	0.136	0.112	0.109						
11	*Semioscopis steinkellneriana*	0.149	0.101	0.116	0.1	0.114	0.123	0.14	0.108	0.121	0.101					
12	*Semioscopis strigulana*	0.155	0.105	0.1	0.091	0.112	0.11	0.134	0.096	0.112	0.098	0.057				
13	*Luquetia lobella*	0.142	0.112	0.125	0.119	0.131	0.125	0.157	0.109	0.109	0.107	0.077	0.075			
14	*Promalactis suzukiella*	0.153	0.103	0.105	0.121	0.127	0.105	0.123	0.108	0.108	0.138	0.145	0.145	0.149		
15	*Oecophora bractella*	0.147	0.123	0.123	0.138	0.134	0.114	0.141	0.13	0.114	0.134	0.147	0.136	0.143	0.107	
16	*Agnoe kurentzovi*	0.175	0.167	0.163	0.173	0.179	0.167	0.203	0.171	0.165	0.181	0.169	0.165	0.171	0.166	0.161
17	*Agnoe josephinae*	0.145	0.125	0.13	0.128	0.14	0.121	0.151	0.127	0.132	0.141	0.141	0.138	0.151	0.121	0.127
18	*Acryptolechia malacobyrsa*	0.147	0.149	0.14	0.155	0.145	0.145	0.151	0.138	0.141	0.168	0.157	0.151	0.157	0.13	0.134
19	*Elachista bifasciella*	0.136	0.151	0.153	0.149	0.155	0.161	0.145	0.149	0.134	0.142	0.161	0.149	0.178	0.157	0.155
20	*Letogenes festalis*	0.175	0.165	0.167	0.175	0.182	0.174	0.204	0.165	0.161	0.177	0.191	0.184	0.187	0.179	0.183
21	*Acria ceramitis*	0.148	0.167	0.173	0.157	0.169	0.174	0.149	0.161	0.153	0.173	0.175	0.169	0.173	0.167	0.155
22	*Scythropiodes issikii*	0.199	0.186	0.179	0.181	0.204	0.188	0.195	0.172	0.18	0.19	0.212	0.207	0.211	0.17	0.206
23	*Odites ussuriella*	0.213	0.194	0.189	0.214	0.208	0.204	0.198	0.202	0.182	0.187	0.206	0.22	0.199	0.194	0.194
24	*Ethmia pusiella*	0.145	0.11	0.121	0.119	0.127	0.121	0.134	0.112	0.112	0.128	0.128	0.143	0.125	0.117	0.125
25	*Autosticha pachysticta*	0.134	0.125	0.134	0.143	0.147	0.132	0.138	0.136	0.13	0.145	0.134	0.136	0.147	0.116	0.116
26	*Autosticha modicella*	0.144	0.116	0.132	0.147	0.141	0.134	0.147	0.127	0.13	0.134	0.138	0.143	0.146	0.132	0.13
27	*Diurnea fagella*	0.161	0.136	0.145	0.125	0.157	0.14	0.149	0.112	0.142	0.155	0.138	0.136	0.149	0.151	0.14
28	*Neoblastobasis spiniharpella*	0.127	0.116	0.125	0.123	0.147	0.118	0.141	0.108	0.125	0.141	0.121	0.128	0.134	0.141	0.132
29	*Neoblastobasis perisella*	0.142	0.134	0.141	0.145	0.141	0.129	0.138	0.136	0.149	0.145	0.151	0.141	0.166	0.143	0.134
30	*Carposina sasakii*	0.151	0.132	0.129	0.128	0.145	0.119	0.145	0.127	0.132	0.147	0.16	0.143	0.159	0.13	0.14
31	*Ypsolopha yasudai*	0.177	0.14	0.14	0.125	0.136	0.147	0.145	0.132	0.141	0.172	0.155	0.16	0.161	0.134	0.155
32	*Psoricoptera arenicolor*	0.14	0.134	0.145	0.136	0.155	0.153	0.155	0.141	0.14	0.127	0.134	0.125	0.151	0.141	0.138
33	*Psoricoptera gibbosella*	0.142	0.132	0.143	0.134	0.153	0.151	0.153	0.143	0.138	0.125	0.132	0.123	0.149	0.14	0.136
34	*Tinea columbariella*	0.173	0.168	0.162	0.166	0.178	0.174	0.182	0.162	0.164	0.178	0.182	0.178	0.194	0.168	0.18
35	*Tineola bisselliella*	0.186	0.168	0.178	0.184	0.176	0.178	0.19	0.172	0.182	0.176	0.18	0.184	0.2	0.162	0.188
36	*Trichophaga tapetzella*	0.226	0.184	0.2	0.21	0.202	0.188	0.212	0.178	0.2	0.206	0.202	0.2	0.201	0.213	0.2

No	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
1																				
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15																				
16																				
17	0.109																			
18	0.167	0.136																		
19	0.187	0.168	0.151																	
20	0.189	0.159	0.188	0.177																
21	0.197	0.159	0.153	0.167	0.136															
22	0.193	0.182	0.185	0.2	0.186	0.19														
23	0.241	0.198	0.21	0.231	0.199	0.194	0.189													
24	0.146	0.121	0.117	0.143	0.163	0.134	0.177	0.174												
25	0.171	0.119	0.114	0.147	0.163	0.147	0.187	0.186	0.091											
26	0.187	0.127	0.132	0.159	0.155	0.142	0.182	0.186	0.101	0.075										
27	0.175	0.145	0.143	0.182	0.205	0.167	0.192	0.217	0.117	0.141	0.136									
28	0.173	0.123	0.127	0.146	0.169	0.147	0.181	0.181	0.107	0.11	0.11	0.118								
29	0.183	0.128	0.143	0.14	0.179	0.151	0.207	0.205	0.114	0.114	0.127	0.144	0.08							
30	0.181	0.149	0.153	0.138	0.163	0.165	0.195	0.202	0.132	0.136	0.143	0.155	0.13	0.138						
31	0.185	0.138	0.143	0.167	0.191	0.198	0.195	0.206	0.127	0.149	0.14	0.153	0.121	0.132	0.158					
32	0.16	0.121	0.145	0.142	0.155	0.136	0.177	0.204	0.138	0.125	0.128	0.157	0.125	0.147	0.136	0.155				
33	0.158	0.119	0.143	0.14	0.153	0.134	0.175	0.202	0.136	0.123	0.128	0.157	0.123	0.145	0.134	0.155	0.002			
34	0.217	0.182	0.164	0.194	0.225	0.2	0.242	0.233	0.153	0.164	0.16	0.178	0.176	0.176	0.17	0.18	0.19	0.188		
35	0.227	0.174	0.184	0.199	0.213	0.211	0.247	0.265	0.18	0.158	0.155	0.18	0.157	0.159	0.159	0.19	0.178	0.176	0.14	
36	0.239	0.215	0.208	0.234	0.234	0.235	0.256	0.269	0.2	0.217	0.198	0.194	0.19	0.186	0.194	0.197	0.209	0.207	0.204	0.218

Table 4. Estimates of evolutionary divergence between sequences of 28SD1 fragment in representatives of oecophoroid moths and other groups of Microlepidoptera

No	Species	1	2	3	4	5	6	7	8	9	10	11
1	*Carcina luridella_254*											
2	*Agonopterix propinquella_275*	0.008										
3	*A. costaemaculella_280*	0.013	0.004									
4	*Agonopterix japonica_286*	0.008	-0.00	0.004								
5	*Agnoea kurentzovi_288*	0.017	0.008	0.013	0.008							
6	*Luquetia lobella_289*	0.013	0.004	0.008	0.004	0.004						
7	*Letogenes festalis_290*	0.008	-0.00	0.004	-0.00	0.008	0.004					
8	*Martyringa ussuriella_294*	0.008	0.008	0.013	0.008	0.017	0.013	0.008				
9	*Odites ussuriella_295*	0.017	0.017	0.021	0.017	0.026	0.021	0.017	0.013			
10	*Autosticha modicella_312*	0.008	-0.00	0.004	-0.00	0.008	0.004	-0.00	0.008	0.017		
11	*Ethmia semipunctata_126*	0.021	0.013	0.017	0.013	0.021	0.017	0.013	0.021	0.03	0.013	
12	*Neoblastobasis sp._96*	0.013	0.013	0.017	0.013	0.021	0.017	0.013	0.013	0.021	0.013	0.026
13	*Dasystoma salicella_91*	0.004	0.004	0.008	0.004	0.013	0.008	0.004	0.004	0.013	0.004	0.017
14	*Periacma sp._97*	0.004	0.004	0.008	0.004	0.013	0.008	0.004	0.004	0.013	0.004	0.017
15	*Deuterogonia pudorina_95*	0.004	0.004	0.008	0.004	0.013	0.008	0.004	0.004	0.013	0.004	0.017
16	*Promalactis parki_ 256*	0.004	0.004	0.008	0.004	0.013	0.008	0.004	0.004	0.013	0.004	0.017
17	*Letogenes festalis_318*	0.013	0.013	0.017	0.013	0.021	0.017	0.013	0.013	0.021	0.013	0.026
18	*Scythropiodes lividula_86*	0.008	0.008	0.013	0.008	0.017	0.013	0.008	0.008	0.008	0.008	0.021
19	*Scythropiodes ussuriella_316*	0.008	0.008	0.013	0.008	0.017	0.013	0.008	0.008	0.017	0.008	0.021
20	*Scythropiodes malivora_330*	0.008	0.008	0.013	0.008	0.017	0.013	0.008	0.008	0.017	0.008	0.021
21	*Eutorna leonidi_335*	0.017	0.017	0.021	0.017	0.021	0.021	0.017	0.017	0.026	0.017	0.03
22	*Rhizosthenes falciformis_337*	0.013	0.013	0.017	0.013	0.021	0.017	0.013	0.013	0.013	0.013	0.026
23	*Anarsia bimaculata_75*	0.017	0.013	0.017	0.013	0.021	0.017	0.013	0.017	0.026	0.013	0.026
24	*Faristenia ussuriella_72*	0.021	0.021	0.026	0.021	0.03	0.026	0.021	0.021	0.03	0.021	0.034
25	*Hypatima venefica_71*	0.039	0.034	0.039	0.034	0.034	0.039	0.034	0.039	0.047	0.034	0.048
26	*Tineidae sp._251*	0.061	0.061	0.056	0.061	0.07	0.066	0.061	0.061	0.07	0.061	0.075

No	12	13	14	15	16	17	18	19	20	21	22	23	24	25
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11														
12														
13	0.008													
14	0.008	-0.00												
15	0.008	-0.00	-0.00											
16	0.008	-0.00	-0.00	-0.00										
17	0.017	0.008	0.008	0.008	0.008									
18	0.013	0.004	0.004	0.004	0.004	0.013								
19	0.013	0.004	0.004	0.004	0.004	0.013	0.008							
20	0.013	0.004	0.004	0.004	0.004	0.013	0.008	-0.00						
21	0.021	0.013	0.013	0.013	0.013	0.013	0.017	0.017	0.017					
22	0.013	0.008	0.008	0.008	0.008	0.017	0.004	0.013	0.013	0.021				
23	0.021	0.013	0.013	0.013	0.013	0.021	0.017	0.017	0.017	0.026	0.021			
24	0.026	0.017	0.017	0.017	0.017	0.026	0.021	0.021	0.021	0.03	0.026	0.013		
25	0.043	0.034	0.034	0.034	0.034	0.034	0.039	0.039	0.039	0.034	0.043	0.03	0.039	
26	0.061	0.056	0.056	0.056	0.056	0.056	0.061	0.061	0.061	0.07	0.066	0.07	0.075	0.094

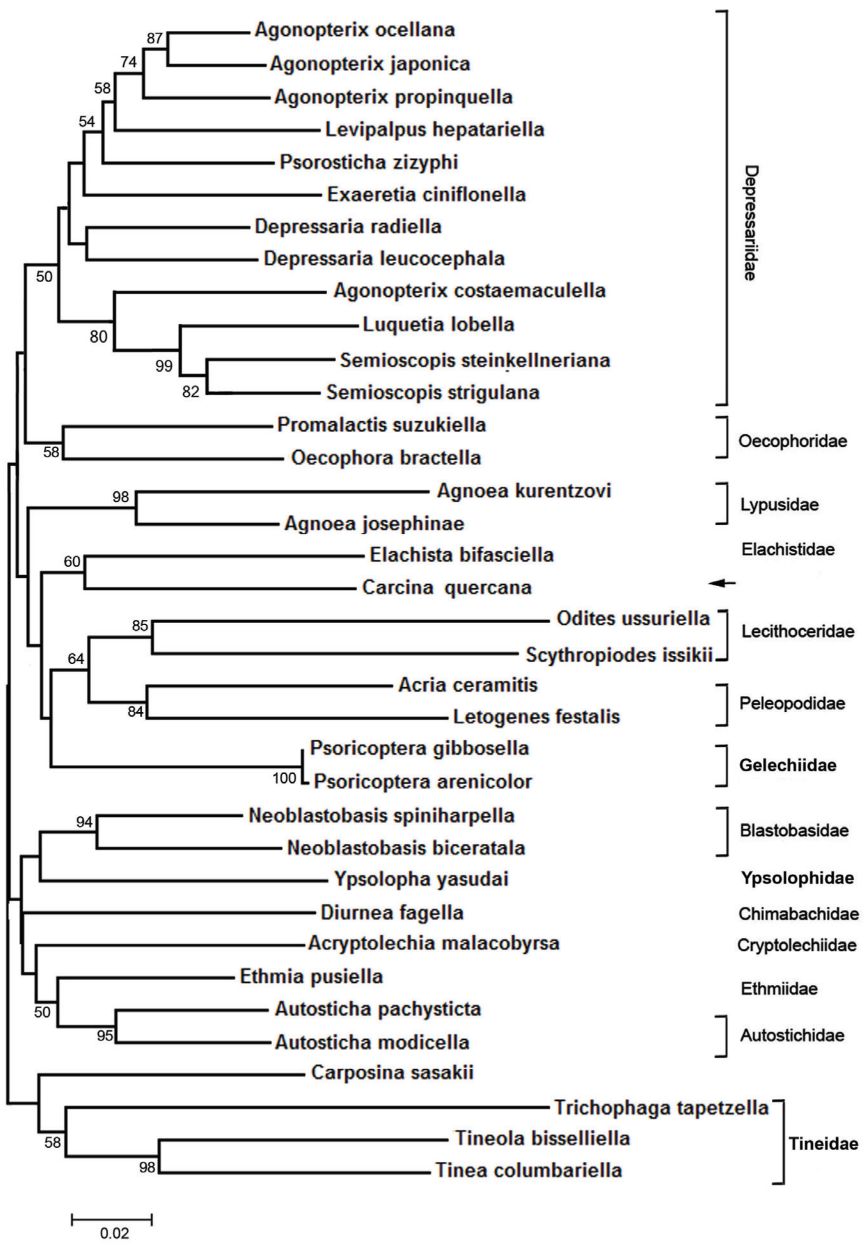


Fig. 6. Phylogenetic relationships of Oecophoroid taxa inferred using Neighbor-joining method. The percentage of replicate trees in which the associated taxa clustered together in the bootstrap test (1000 replicates) is shown from 50%.

(0.161). Minimal genetic divergence between *Carcina* and Blastobasidae (0.127–0.142), Autostichidae (0.134–0.144), Elachistidae (0.136) is revealed. The parameters in the listed intervals are corresponding to the genetic distances between *Carcina* and the species from Gelechiidae (0.14–0.142), which is belonging to sister lineage within superfamily Gelechioidea. It should be noted that maximal parameters of divergence within superfamily Gelechioidea equal to the genetic distances between examined genus and other microlepidopteran groups – Carposinidae (0.151), Ypsolophidae (0.177) and Tineidae (0.173–0.226).

The estimates of evolutionary divergence between sequences of 28SDI fragment in the examined representatives of oecophoroid complex show that genus *Carcina* has minimal genetic distances with the species from Chimabachidae (0.004) and Oecophoridae (0.004–0.008) (Table 4). The group consisting of the families Peleopodidae (0.008), Autostichidae (0.008), Depressariidae (0.008–0.017), Lecithoceridae (0.008–0.017) and Blastobasidae (0.013) are with overlapping intervals of genetic distances. Lypusidae (0.017) and some representatives from Lecithoceridae (0.017) are more deviated. The largest evolutionary distances were found between *Carcina* and representatives from Gelechiidae (0.017–0.039) and Ethmiidae (0.021).

The tree of evolutionary relationships of oecophoroid taxa is constructed on the base of phylogenetic analysis of 36 nucleotide sequences of mtCOI fragment (Fig. 6). The genus *Carcina* is clustered together with species from the family Elachistidae. The families Depressariidae and Oecophoridae, which are considered as appropriate taxa for genus *Carcina*, are joined into one clade opposed to clade with nested *Carcina.*

DISCUSSION AND CONCLUSION

Taxonomic position of *Lecithocera luridella* Christoph, 1882

The taxonomic position of the East-Asian species *luridella* is established on the base of high similarity in morphology of male copulatory apparatus with type species of the genus *Carcina*. Thus, three species should be included into the genus *Carcina*: *Carcina quercana* (Fabricius, 1775), type species, common in the Western Palearctic and in Western North America; *Carcina haemographa* Meyrick, 1937 known from Central Africa; and *Carcina luridella* (Christoph, 1882), distributed in East Asia.

Taxonomic position and status of the *Carcina* Hübner, [1825]

The assessment of the pairwise distances in representatives of oecophoroid families and other Microlepidoptera shows that *Carcina* is equally-diverged from Depressariidae (0.142–0.163) and Oecophoridae (0.147–0.153) on the base of mtCOI and has compatible genetic distances with currently separated oecophoroid families – Chimabachidae (0.004), Oecophoridae (0.004–0.008), Peleopodidae (0.008), Autostichidae (0.008), Depressariidae (0.008–0.017) and Lecithoceridae (0.008–0.017) based on the 28SD1.

Besides, the genetic divergence between *Carcina* and some representatives of the families Depressariidae, Lecithoceridae and Lypusidae (0.142 on COI; 0.017 on 28SD1) is same as between this genus and species from Gelechiidae (0.14–0.142 on COI; 0.017 on 28SD1). The genetic distances between oecophoroid families are low not only on the nuclear fragment 28SD1, but also on the fragment mtCOI-II (8.5–11.1%)) that was shown in previously study (Trofimova & Ponomarenko, 2015).

Comparing these parameters with intraspecific genetic distances in other group of Lepidoptera and other insects, they are corresponding to the genetic divergence between close species or species belonging to the related genera (Cognato, 2006). On the other hand, despite of the low genetic distances between representatives of the oecophoroid families and within superfamily Gelechioidea at whole, the parameters listed above are comparable with the average pairwise distances between taxa from subfamily Microgastrinae (Hymenoptera), which is 0.18 for the sequenced gene COI (Banks & Whitfield, 2006).

Comparison of the recently published phylogenetic trees reconstructed on the base of comprehensive analyses of morphological and molecular data indicates that *Carcina* equiprobable nested within clades included different oecophoroid families (clades are given in Newick tree format (Olsen, 1990; Cardona *et al*., 2008), support values is indicated by subscript numerals after the parenthesis, bootstrap less 50% is not shown):

(Lypusidae, (Carcinidae: *Carcina*, (Stenomatidae, (Chimabachidae, Elachistidae)$_2$)$_2$)$_2$)$_2$ in Kaila, 2004 (Bremer support is shown);

((((Lecithoceridae, Peleopodidae)$_{55}$, *Carcina*)$_{66}$, Depressariidae)$_{48}$, Elachistidae: *Aeolanthes*)$_{16}$ in Kaila *et al.*, 2011 (here and below bootstrap support is shown);

(((Lecithoceridae, Peleopodidae)$_{79}$ (*Carcina*, Depressariidae: *Aeolanthes*)$_{23}$)$_{33}$, Elachistidae)$_{28}$ in Heikkila *et al*., 2013;

(Lypusidae, ((Elachistidae, *Carcina*)$_{60}$, ((Lecithoceridae, Peleopodidae)$_{64}$, Gelechiidae))) in present study.

It is visible that genus *Carcina*, being genetically equal-deviated, alternately clustered together with families Depressariidae, Peleopodidae, Elachistidae, Chimabachidae, Lecithoceridae, and Lypusidae, from which is logically suggested that *Carcina* should be of the same taxonomic status as listed above taxa.

Summarizing the obtained results, the taxonomic position and status of the genus *Carcina* in the system of oecophoroid moths could be solved by one of two equally probable ways.

Since all modern separate families are weakly diverged groups, as evidenced by the reconstructed trees frequently with unresolved branches and changeable rooting of basal branches with low bootstrap support, it would be logically to combine weakly diverged families into one taxon. The modern tendency to split taxa into small groups with high taxonomic rank is not always reasonable. According to the written above, the genus *Carcina* should be placed in the family Oecophoridae sensu lato, along with a number of relatively newly established weakly diverged families. This is more or less justified, in view of the recent frequent redistribution of groups between families, accompanied by a change in their taxonomic rank (Kaila, 2004; Kaila *et al*., 2011; Heikkila *et al*., 2013; Sohn *et al*., 2015).

The second way to solve this problem is associated with maintaining a unified approach in the allocation of high rank taxa. This way becomes more popular and is associated with the fragmentation of taxa into small monophyletic groups. This is not always reasonable, but it removes the problem of creating heterogeneous taxa, monophyly of which is not evident. Therefore, taking into account that *Carcina* is equal-deviated from Depressariidae, Oecophoridae, Lecithoceridae and other oecophoroid taxa on the base of molecular data, this group should be considered as an independent taxon of family rank Carcinidae, that has been already proposed by Leraut (1992) and the authors of present study are supporting this decision.

However the family group name Carcinidae Meyrick, 1906, which is based on the genus name *Carcina* Hübner, [1825] invalid being a junior homonym of Carcinidae MacLeay, 1838, which is based on the genus name *Carcinus* Leach, 1814 in Malacostraca (van Nieukerken *et al*., 2011). According to ICZN (1999), Art. 55.3, a case when homonymy results from similarity but not identity of the generic names must be referred to the International Commission on Zoological Nomenclature for a ruling to remove homonymy.

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REFERENCES

Banks, J.C. & Whitfield, J.B. 2006. Dissecting the ancient rapid radiation of microgastrine wasp genera using additional nuclear genes. *Molecular Phylogenetics and Evolution*, 41: 690–703.

Beccaloni, G., Scoble, M., Kitching, I., Simonsen, T., Robinson, G., Pitkin, B., Hine, A. & Lyal, C. (Eds). 2003. The Global Lepidoptera Names Index (LepIndex). World Wide Web electronic publication. URL: http://www.nhm.ac.uk/our-science/data/lepindex/lepindex/ (accessed 20 May 2018)

Cardona G., Rosselló F. & Valiente, G. 2008. Extended Newick: it is time for a standard representation of phylogenetic networks. *BMC Bioinformatics*, 9: 532.

Christoph, H. 1882. Neue Lepidopteren des Amurgebietes. *Bulletin de la Société impériale des naturalistes de Moscou,* 57(2): 5–47.

Cognato, A.I. 2006. Standard percent DNA sequence difference for insects does not predict species boundaries. *Journal of Economic Entomology*, 99: 1037–1045.

Falkovich, M.I. & Stekolnikov, A.A. 1978. Technique of collecting and preparation of lepidopterans. P. 25–27. In: Skarlato, O.A. (Ed.). *Key to the insects of the European part of the USSR*. *Vol. 4. Lepidoptera. Part 1*. Nauka, Leningrad. [In Russian]

Fauna Europaea. 2017. URL: http://www.faunaeur.org (accessed: 15 May 2018)

Fetz, R. 1994. Larvalmorphologische Beitrage zumphylogenetischen System der ehemaligen Oecophoridae (Lepidoptera, Gelechioidea). *Neue entomologische Nachrichten*, 33: 1–273.

Heikkila, M., Mutanen, M., Kekkonen, M. & Kaila, L. 2014. Morphology reinforces proposed molecular phylogenetic affinities: a revised classification for Gelechioidea (Lepidoptera). *Cladistics*, 30: 563–589.

Hodges, R.W. (Ed.). 1983. Check List of the Lepidoptera of America North of Mexico. EW Classey Ltd. and the Wedge Entomological Research Foundation, London. 284 pp.
International Commission on Zoological Nomenclature. 1999. *International code of zoological nomenclature, Fourth Edition*. International Trust for Zoological Nomenclature, London. 306 pp.
Kaila, L. 2004. Phylogeny of the superfamily Gelechioidea (Lepidoptera: Ditrysia): an exemplar approach. *Cladistics*, 20: 303–340.
Kaila, L., Mutanen, M. & Nyman, T. 2011. Phylogeny of the megadiverse Gelechioidea (Lepidoptera): adaptations and determinants of success. *Molecular Phylogenetics and Evolution*, 61: 801–809.
Kumar, S., Stecher, G. & Tamura, K. 2016. MEGA7: Molecular Evolutionary Genetics Analysis Version 7.0 for Bigger Datasets. *Molecular Biology and Evolution*, 33(7): 1870–1874.
Larsen, N. 1992. Higher order interactions in 23S rRNA. *Proceeding of the National Academy of Sciences of the United States of America*, 89: 5044–5048.
Lepiforum: Bestimmung von Schmetterlingen (Lepidoptera) und ihren Praimaginalstadien. URL: http://www.lepiforum.de/ (accessed: 21 May 2018)
Leraut, P.J.A. 1992. Quelques changements dans la nomenclature des lépidoptères de France (Lepidoptera). *Entomologica Gallica*, 3(2): 78.
Lvovsky, A.L. 1981. Fam. Oecophoridae. P. 560–638. In: Medvedev, G.S. (Ed.). *Key to the insects of European part of the USSR. Vol. 4. Lepidoptera. Part 2.* Nauka, Leningrad. [In Russian]
Lvovsky, A.L. 1999. Fam. Lecithoceridae (Timyridae). P. 21–28. In: Kononenko V.S. (Ed.). *Key to the insects of the Russian Far East. Vol. 5. Trichoptera and Lepidoptera*. Dalnauka, Vladivostok. [In Russian]
Lvovsky, A.L. 2001. New and little known species of flat and wind-winged moths (Lepidoptera, Depressariidae, Oecophoridae) in the fauna of Russia and adjacent countries. *Zoologicheskii Zhurnal*, 80(12): 1459–1467. [In Russian]
Lvovsky, A.L. 2003. Check-list of the broad-winged moths (Oecophoridae s. l.) of Russia and adjacent countries. *Nota Lepidopterologica*, 25(4): 213–220.
Lvovsky, A.L. 2008. Fam. Oecophoridae. P. 65–68. In: Sinev, S.Yu. (Ed.). *Catalogue of the Lepidoptera of Russia*. KMK Scientific Press, St. Petersburg & Moscow. [In Russian]
Lvovsky, A.L. 2016. Fam. Depressariidae, Fam. Peleopodidae, Fam. Xyloryctidae, Fam. Chimabachidae, Fam. Cryptolechiidae, Fam. Oecophoridae, Fam. Lecithoceridae. Pp. 76–81, 87–93. In: Beljaev E.A. (Ed.). *Annotated catalogue of the insects of Russian Far East*. *Vol. II. Lepidoptera.* Dalnauka, Vladivostok. [In Russian]
Meyrick, E. 1906. Description of Australian Tineina. *Transactions and proceedings and Report of the Royal Sociert of South Australia*, 30: 33–66.
Meyrick, E. 1922. Fam. Oecophoridae. In: Wytsman P. (Ed.). *Genera Insectorum. Lepidoptera Heterocera*. Bruxelles, 180: 224 pp. + 6 plates.
Meyrick, E. 1925. Fam. Gelechiadae. In: Wytsman P. (Ed.). *Genera Insectorum. Lepidoptera Heterocera*. Bruxelles, 1925. P. 1–290, pl. 1–5.
Mikkelsen, P.M., Bieler, R., Kappner, I. & Rawlings, T.A. 2006. Phylogeny of Veneroidea (Mollusca: Bivalvia) based on morphology and molecules. *Zoological Journal of the Linnean Society*, 148(3): 439–521.
Minet, J. 1990. Remaniement partiel de la classification des Gelechioidea, essentiellement en fonction de caractères pré-imaginaux (Lepidoptera, Ditrysia). *Alexanor*, 16(1989): 239–255.

Moriuti, S. 1982. Gelechiidae. In: Inoue, H. Sugi, S., Kuroko, H., Moriuti, S., Kawabe, A. & Owada, M. *Moths of Japan*. Kodansha, Tokyo. 1: 275–288, 2: 212–215. [In Japanese]

van Nieukerken, E.J., Kaila, L., Kitching, I.J., Kristensen, N.P., Lees, D.C., Minet, J., Mitter, C., Mutanen, M., Regier, J.C., Simonsen, T.J., Wahlberg, N., Yen, S.-H., Zahiri, R., Adamski, D., Baixeras, J., Bartsch, D., Bengtsson, B._A., Brown, J.W., Bucheli, S.R., Davis, D.R., De Prins, J., De Prins, W., Epstein, M.E., Gentili-Poole, P., Gielis, C., Hättenschwiler, P., Hausmann, A., Holloway, J.D., Kallies, A., Karsholt, O., Kawahara, A.Y., Koster, J.C., Kozlov, M.V., Lafontaine, J.D., Lamas, G., Landry, J.-F., Lee, S., Nuss, M., Park, K.-T., Penz, C., Rota, J., Schmidt, B.C., Schintlmeister, A., Sohn, J.-S., Solis, M.A., Tarmann, G.M., Warren, A.D., Weller, S., Yakovlev, R.V., Zolotuhin, V.V. & Zwick, A. 2011. Order Lepidoptera. In: Zhang, Z.-Q. (Ed.). Animal biodiversity: an outline of higher-level classification and survey of taxonomic richness. *Zootaxa*, 3148: 212–221.

Nye, I.W. B. & Fletcher, D.S. 1991. *The Generic Names of Moths of the World. Vol. 6, Microlepidoptera*. Trustees of the British Museum (Natural History), London. 368 pp.

Olsen, G. 1990. "Newick's 8:45" Tree Format Standard. URL: http://evolution.genetics.washington.edu/phylip/newick_doc.html (accessed 25 May 2018).

Savela, M. 2001. Lepidoptera and Some Other Life Forms. URL: http://www.nic.funet.fi/ (accessed 25 May 2018).

Sinev, S.Yu. (Ed.). 2008. *Catalogue of the Lepidoptera of Russia*. KMK Scientific Press, St. Petersburg & Moscow. 424 pp. [In Russian]

Sohn, J.Ch., Regier, J.C., Mitter, Ch., Adamski, D., Landry, J.-F., Heikkila, M., Park, K.T., Harrison, T., Mitter, K., Zwick, A., Kawahara, A.Y., Cho, S., Cummings, M.P. & Schmitz, P. 2015/2016. Phylogeny and feeding trait evolution of the mega-diverse Gelechioidea (Lepidoptera: Obtectomera): new insight from 19 nuclear genes. *Systematic Entomology*, 2015 online/ 2016. 41(1): 112–132.

Svenska fjärilar / Fjärilar Lepidoptera. 2018. URL: http://www2.nrm.se/en/svenska_fjarilar/svenska_fjarilar.html (accessed 21 May 2018)

Trofimova, P.N. & Ponomarenko, M.G. 2015. Estimation of divergence of flat moths (Lepidoptera: Depressariidae) on the base of sequences mtCOI-II and nuclear ribosomal (28SD1) genes. *A.I. Kurentsov's Annual Memorial Meetings*, 26: 161–169. [In Russian]

Ueda, T. 2013. Oecophoridae. Pp. 38, 213–219. In: Hirowatari, T. Nasu, Y., Sakamaki, Y. & Kishida, Y. (Eds). *The Standard of Moths in Japan*. Vol. III. Gakken Education Publishing, Tokyo.

Wheeler, J. 2018. Moth Dissection UK. URL: http://mothdissection.co.uk -V.3.5 (accessed 22 May 2018)